Geographic Differences in Resource Selection Under Different GHG Constraints

IRP Modeling Advisory Group

Staff Response to Office Hours Question

10/24/2017

About These Slides

- The following slides provide a detailed response to a question posed by SCE as part of a series of Office Hours webinars hosted by the Integrated Resource Planning Modeling Advisory Group in October 2017 (Office Hours #3, SCE Question #3).

Summary

SCE Question:

"Since RESOLVE is a linear programming problem, for two cases, A and B, whenever A has a tougher GHG constraint than B, then the solution for A should include all the resources of B plus additional resources. Yet we see that 42mmt_Ref has 700 MW more Southern_Nevada_Solar than 30mmt_Ref. Every other RESOLVE Resource Name has the same or less selected build. We also see that 99mmt_Ref has 62 MW of Mountain_Pass_El_Dorado_Solar while 42mmt_Ref has 0. Why would portfolios flip in this way instead of simply adding resources?"

E3 investigated the first of these instances:

700 MW of Southern_Nevada_Solar is optimal in the 42mmt_Ref case but is not built in 30mmt_Ref case

E3 found that:

Wind and geothermal outcompete Southern_Nevada_Solar for limited transmission capacity in the 30mmt_Ref case because wind and geothermal are more cost-effective in the 30mmt_Ref case than in the 42mmt_Ref case.

Southern_Nevada_Solar is located in the transmission zone Mountain_Pass_El_Dorado. This zone has 3,000 MW of space on the existing transmission system (800MW FCDS + 2200MW EO) – building more than 3000 MW of resources in this zone would incur a significant transmission upgrade cost.

Input file (sorted): resource_tx_zones.tab

	resource	tx_zone_of_resource
2	Central_Valley_North_Los_Banos_Solar	Central_Valley_North_Los_Banos
3	Central_Valley_North_Los_Banos_Wind	Central_Valley_North_Los_Banos
4	Greater_Carrizo_Solar	Greater_Carrizo
5	Greater_Carrizo_Wind	Greater_Carrizo
6	Greater_Imperial_Solar	Greater_Imperial
7	Greater_Imperial_Geothermal	Greater_Imperial
8	Kramer_Inyokern_Solar	Kramer_Inyokern
9	Mountain_Pass_El_Dorado_Solar	Mountain_Pass_El_Dorado
10	Southern_Nevada_Solar	Mountain_Pass_El_Dorado
11	Southern_Nevada_Wind	Mountain_Pass_El_Dorado
12	Southern_Nevada_Geothermal	Mountain_Pass_El_Dorado
13	Distributed_Solar	None

Four resources compete for transmission capacity in the Mountain_Pass_El_Dorado zone, including:
Southern_Nevada_Solar
Southern_Nevada_Wind
Southern_Nevada_Geothermal

Input file: tx_zones.tab

	tx_zone	tx_deliverability_cost_per_mw_yr	fully_deliverable_new_tx_threshold_mw	energy_only_tx_limit_mw
2	Northern_California	52230.27243	659.7932	4232
3	Solano	13275.04592	0	700
4	Central_Valley_North_Los_Banos	27910.53785	697.06	0
5	Westlands	10861.52976	1378.25964	700
6	Greater_Carrizo	88752.48177	0	160
7	Tehachapi	13245.76799	4611.962	800
8	Kramer_Invokern	53606.40224	975.6568	1000
9	Mountain_Pass_El_Dorado	33555.94559	800	2200
10	Southern_California_Desert	81835.443	0	0
11	Riverside_East_Palm_Springs	60165.22174	2815.768	2550
12	Greater_Imperial	60165.22174	623.6424	1900
13	None	0	0	0

There is 3,000 MW of space on the existing network in this zone before new transmission must be built

Building new transmission in Mountain_Pass_El_Dorado would cost $36k/MW-yr, a significant cost

In the 42mmt_ref case, Resolve builds 3000 MW of Southern_Nevada_Solar, strongly suggesting that this resource is a high quality solar resource, but also that Resolve is not willing to pay to expand transmission capacity beyond the 3000 MW limit to capture additional Southern_Nevada_Solar resource capacity. This implies that there are slightly more expensive and/or lower quality solar resources that the model would rather build than incur the cost to build new transmission for additional Southern_Nevada_Solar.
The model does not build geothermal or wind in Mountain_Pass_El_Dorado in the 42mmt_ref case

42mmt_ref output file (sorted): resource_build.csv

	peri	resource	zon	contra	technology	planned_capacity_m	new_build_m	cumulative_new_build_m	total_capacity_m	transmission_zone	ully_deliverable_capacity_m	energy_only_capacity_m	new_
9	2030	Mountain_Pass_El_Dorado_Solar	CAISO	CAISO	Solar	0	0	0	0	Mountain_Pass_El_Dorado	0	0	
5	2030	Southern_Nevada_Geothermal	CAISO	CAISO	Geothermal	0	0	0	0	Mountain_Pass_El_Dorado	0	0	
6	2030	Southern_Nevada_Solar	CAISO	CAISO	Solar	0	0	3000	3000	Mountain_Pass_El_Dorado	800	2200	
7	2030	Southern_Nevada_Wind	CAISO	CAISO	Wind	0	0	0	0	Mountain_Pass_El_Dorado	0	0	

3000 MW Southern_Nevada_Solar built in Mountain_Pass_El_Dorado – nothing else

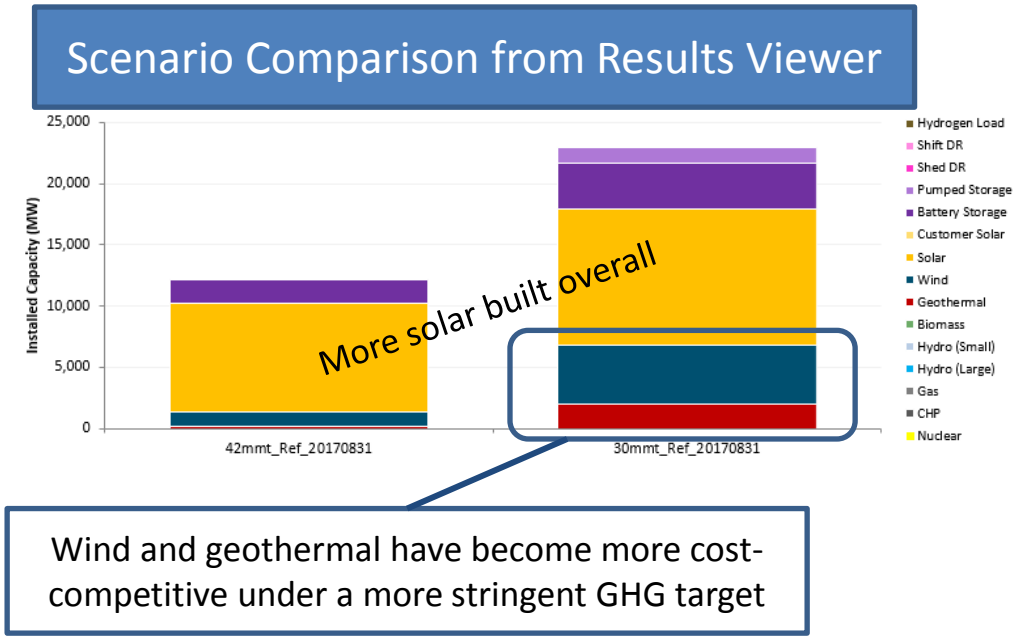
In the 30mmt_ref case, the model still builds 3000MW of renewable resources in the Mountain_Pass_El_Dorado transmission zone, but the mix shifts to include wind and geothermal. The model builds the maximum resource potential for Southern_Nevada_Geothermal (256 MW) and Southern_Nevada_Wind (441 MW), leaving 3000-256-441=2302 MW of transmission in the Mountain_Pass_El_Dorado transmission zone for Southern_Nevada_Solar.

30mmt_ref output file (sorted): resource_build.csv

	A	B	C	D	E	F	G	H	I	L	M	N
	period	resource	zone	contract	technology	planned_capacity_m	new_build_mw	cumulative_new_build_mw	total_capacity_mw	transmission_zone	fully_deliverable_capacity_mw	energy_only_capacity_mw
8	2030	Mountain_Pass_El_Dorado_Solar	CAISO	CAISO	Solar	0	0	0	0	Mountain_Pass_El_Dorado	0	0
4	2030	Southern_Nevada_Geothermal	CAISO	CAISO	Geothermal	0	256	256	256	Mountain_Pass_El_Dorado	0	256
5	2030	Southern_Nevada_Solar	CAISO	CAISO	Solar	0	0	2302.07	2302.07	Mountain_Pass_El_Dorado	800	1502.07
6	2030	Southern_Nevada_Wind	CAISO	CAISO	Wind	0	441.93	441.93	441.93	Mountain_Pass_El_Dorado	0	441.93

3000 MW build across all resources located in the Mountain_Pass_El_Dorado transmission zone

- Wind and geothermal are more cost–competitive at more stringent GHG targets, forcing some Southern_Nevada_Solar out of the Mountain_Pass_El_Dorado transmission zone in favor of wind and geothermal resources.
- The total amount of solar built increases between 42mmt_Ref and 30mmt_Ref, so more solar in aggregate is built as the GHG target becomes more stringent.
- <u>The 698 MW of Southern_Nevada_Solar that is not built in the 30mmt_ref case has moved to other transmission zones with available transmission capacity.</u>



Sequencing Considerations

- In both the 42 MMT and 30 MMT cases, RESOLVE builds Southern_Nevada_Solar in 2022:
  - 3,000 MW in 42 MMT case
  - 2,298 MW in 30 MMT case
- RESOLVE does not build any more Southern_Nevada_Solar after 2022 in either case.
  - RESOLVE does not find wind and geothermal cost competitive in the 42 MMT case, so it builds the full 3,000 MW of Southern_Nevada_Solar in 2022.
  - RESOLVE builds only 2,298 MW of Southern_Nevada_Solar in the 30 MMT case in 2022 because it's waiting to fill the rest of the transmission capacity (698 MW) with wind and geothermal in 2030.

Conclusions

- There is nothing inherent to linear programming that implies that for two cases, A and B, whenever A has a more stringent GHG constraint than B, then the solution for A should include all the resources of B plus additional resources.
- RESOLVE does not add resources year by year (as did the RPS Calculator), but instead considers the full time horizon when choosing which resources to select in each modeled year.
- “Knowing” that it must achieve a more stringent GHG target in 2030 may induce RESOLVE to make different choices in earlier years than it otherwise would if it was seeking to satisfy a less stringent target at the end of the study period.